US005462463A

United States Patent [19]

Meisenburg et al.

[11] **Patent Number: 5,462,463**

[45] **Date of Patent: Oct. 31, 1995**

[54] **MARINE DUAL PROPELLER LOWER BORE DRIVE ASSEMBLY**

[75] Inventors: **Gary L. Meisenburg**; **Edward C. Eick**; **Phillip D. Magee**; **Charles M. Mixon**, all of Stillwater, Okla.; **Robert B. Weronke**, Oshkosh, Wis.; **Waylon D. Shields**; **Woody R. Smith**, both of Stillwater, Okla.; **Steven J. Pavey**, Carney, Okla.

[73] Assignee: **Brunswick Corporation**, Skokie, Ill.

[21] Appl. No.: **342,837**

[22] Filed: **Nov. 21, 1994**

Related U.S. Application Data

[63] Continuation of Ser. No. 69,163, May 28, 1993, Pat. No. 5,366,398, which is a continuation-in-part of Ser. No. 889, 530, May 27, 1992, Pat. No. 5,249,995.

[51] **Int. Cl.**[6] **B63C 9/00**

[52] **U.S. Cl.** **440/80**; 440/89; 440/900

[58] **Field of Search** 440/75, 76, 78, 440/88, 89, 900, 80, 79, 81

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,931,783	1/1976	Croisant	115/34 R
3,943,790	3/1976	Meyer	440/78
3,952,686	4/1976	Pichl	115/17
4,529,387	7/1985	Brandt et al.	416/129
4,619,584	10/1986	Brandt	440/66
4,630,719	12/1986	McCormick	192/21
4,679,682	7/1987	Gray, Jr. et al.	192/21
4,698,036	10/1987	Brandt	440/62
4,741,670	5/1988	Brandt	416/129
4,764,135	8/1988	McCormick	440/83
4,773,215	9/1988	Winberg et al.	60/324
4,790,782	12/1988	McCormick	440/61
4,792,315	12/1988	Karrasch et al.	440/83
4,795,382	1/1989	McCormick	440/81
4,832,635	5/1989	McCormick	440/78
4,832,636	5/1989	McCormick	440/80
4,840,136	6/1989	Brandt	440/78
4,863,406	9/1989	Bland et al.	440/83
4,869,121	9/1989	Meisenburg	74/323
4,869,694	9/1989	McCormick	440/83
4,871,334	10/1989	McCormick	440/89
4,897,058	1/1990	McCormick	440/80
4,900,281	2/1990	McCormick	440/28
4,948,384	8/1990	Bland et al.	440/78
4,993,848	2/1991	John	440/78
5,112,260	5/1992	Bland et al.	440/88
5,249,995	10/1993	Meisenburg et al.	440/81

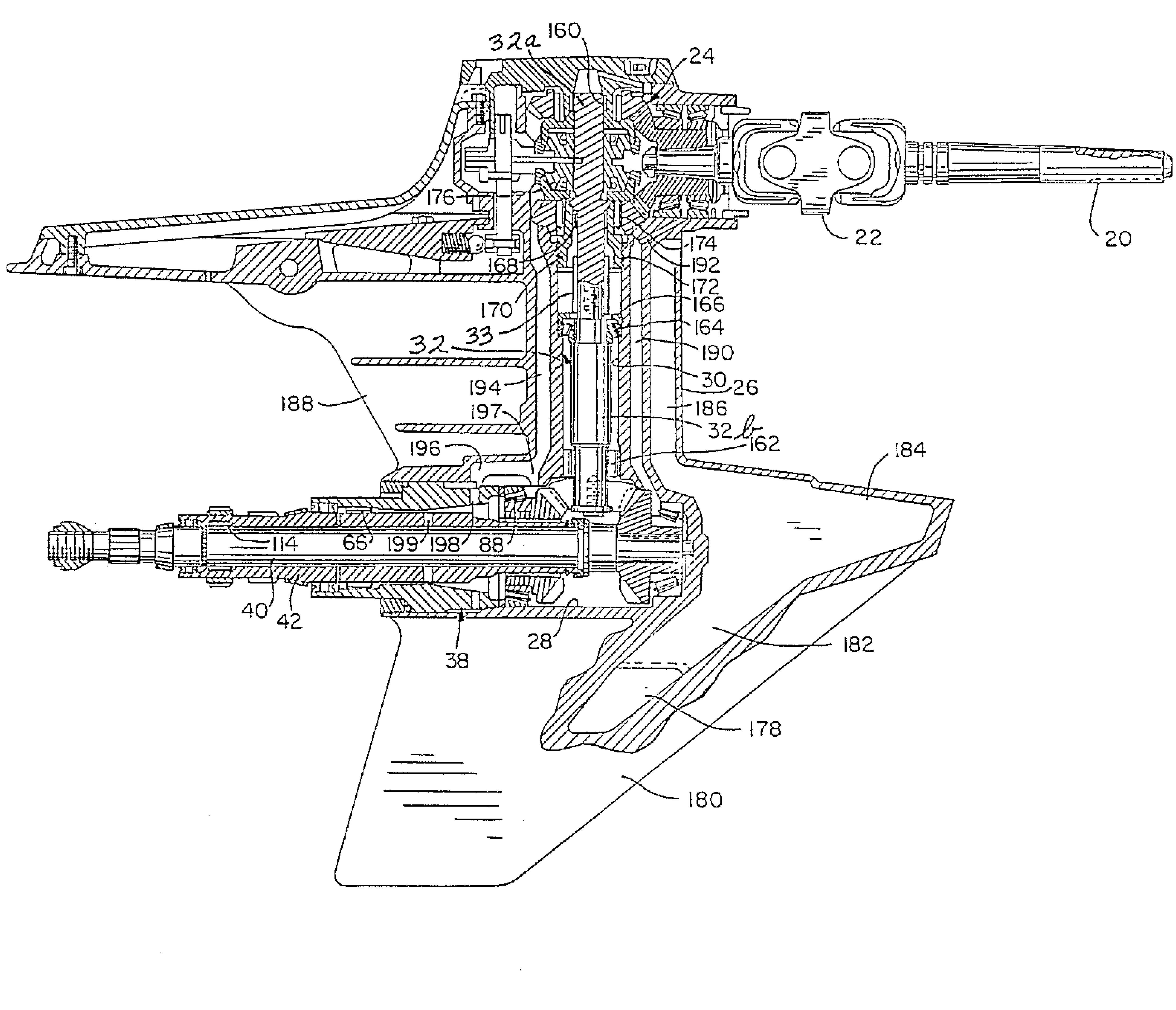
Primary Examiner—Edwin L. Swinehart

Attorney, Agent, or Firm—Andrus, Sceales, Starke & Sawall

[57] **ABSTRACT**

A marine drive (**10**, **310**) has two counter-rotating propellers (**12** and **14**, **312** and **314**). Inner and outer concentric counter-rotating propeller shafts (**40** and **42**, **340** and **338**) are supported by a spool (**38**, **336**) in the lower horizontal bore (**28**, **328**). Passages are provided in the housing for communicating lubrication and/or exhaust with the horizontal bore. Locking structure (**50**, **404**) holds the driven gears and bearings in place in the lower horizontal bore.

7 Claims, 7 Drawing Sheets



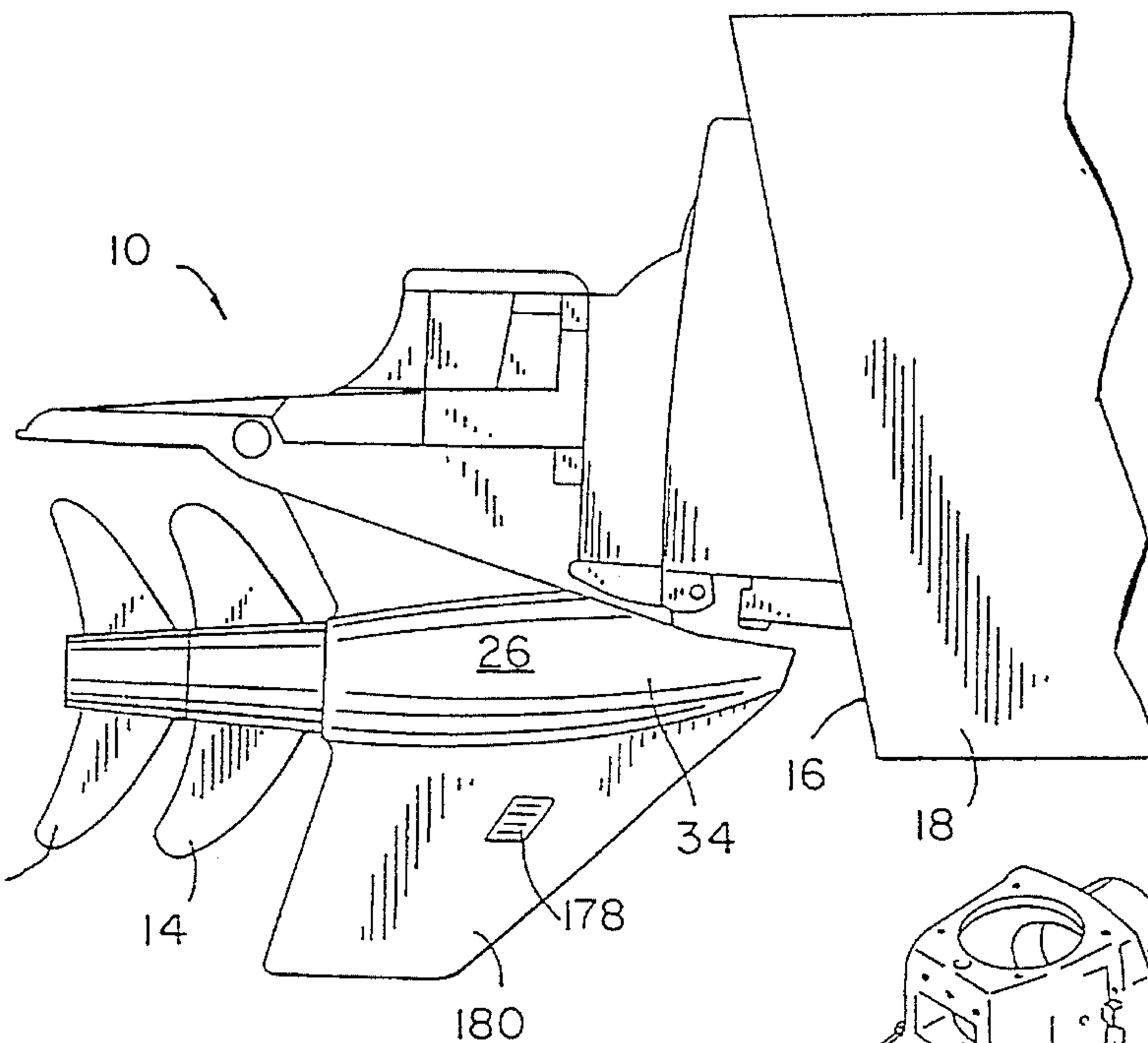

10
26
34
12
14
178
180
16
18

FIG. 1

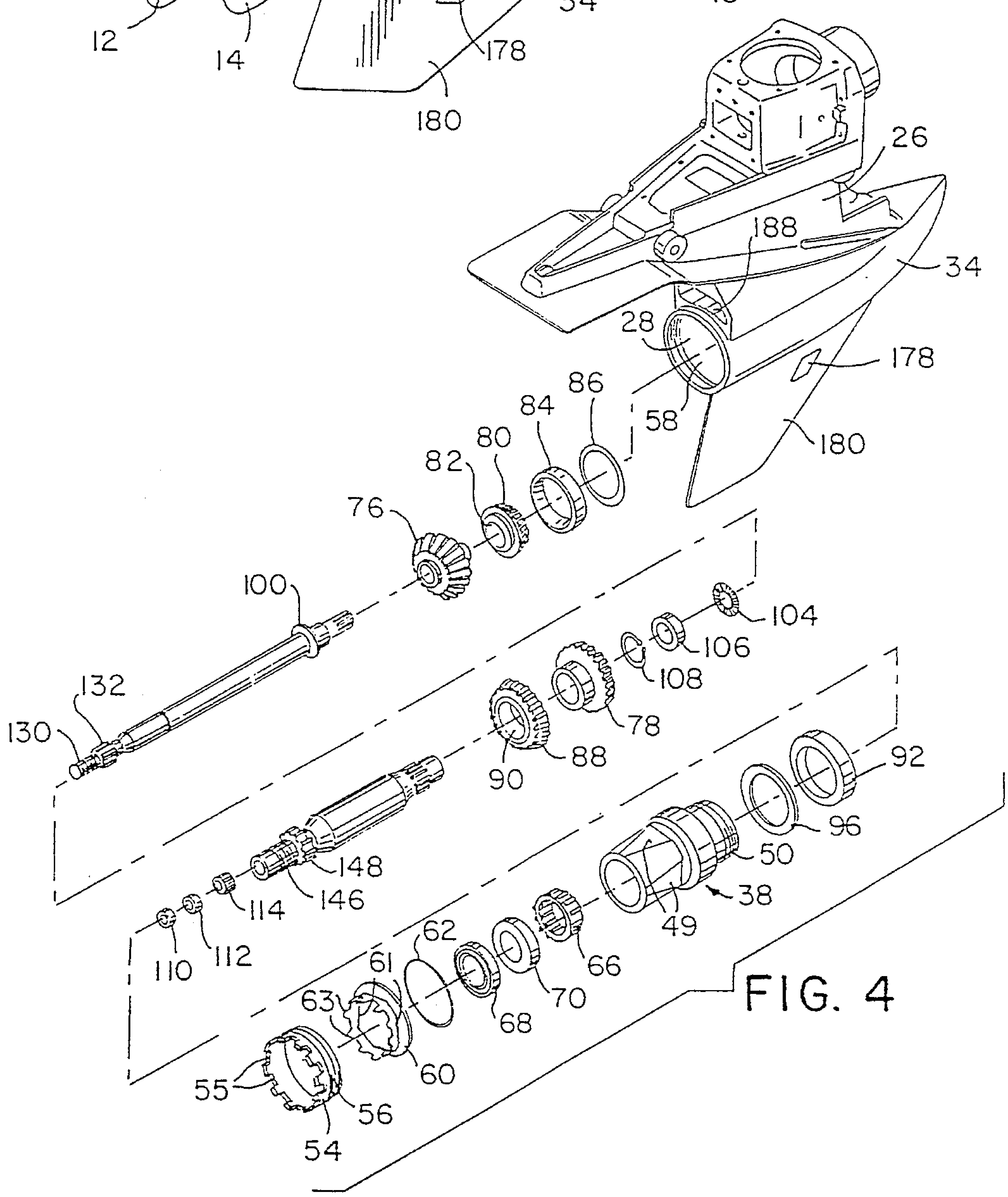

26
188
34
28
178
86
84
58
180
80
82
76
100
104
106
108
78
132
130
88
90
92
96
148
146
114
50
38
112
110
49
62
66
61
70
63
68
60
55
56
54

FIG. 4

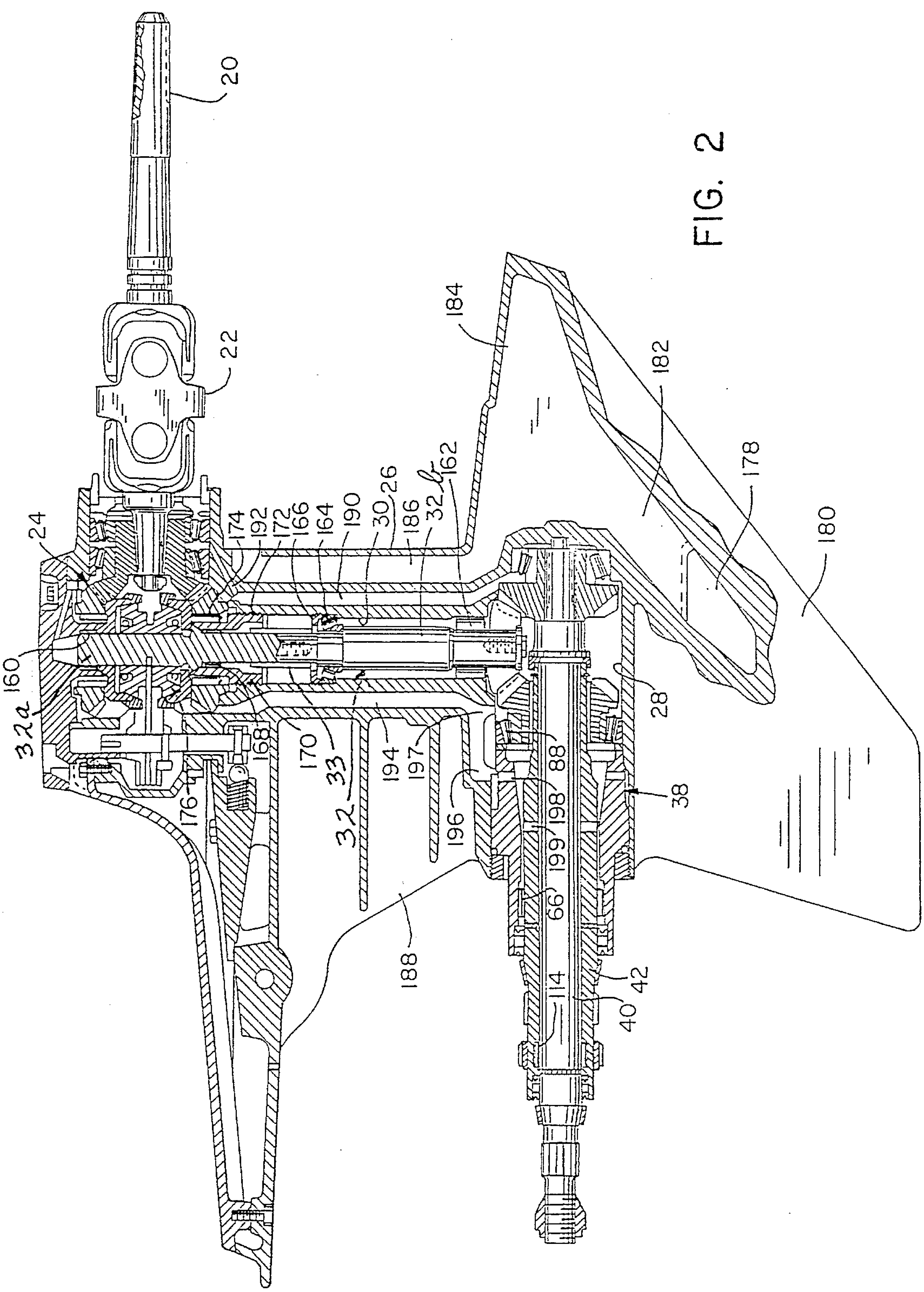

20
22
24
26
28
30
32
32a
32b
33
38
40
42
66
88
114
160
162
164
166
168
170
172
174
176
178
180
182
184
186
188
190
192
194
196
197
198
199

FIG. 2

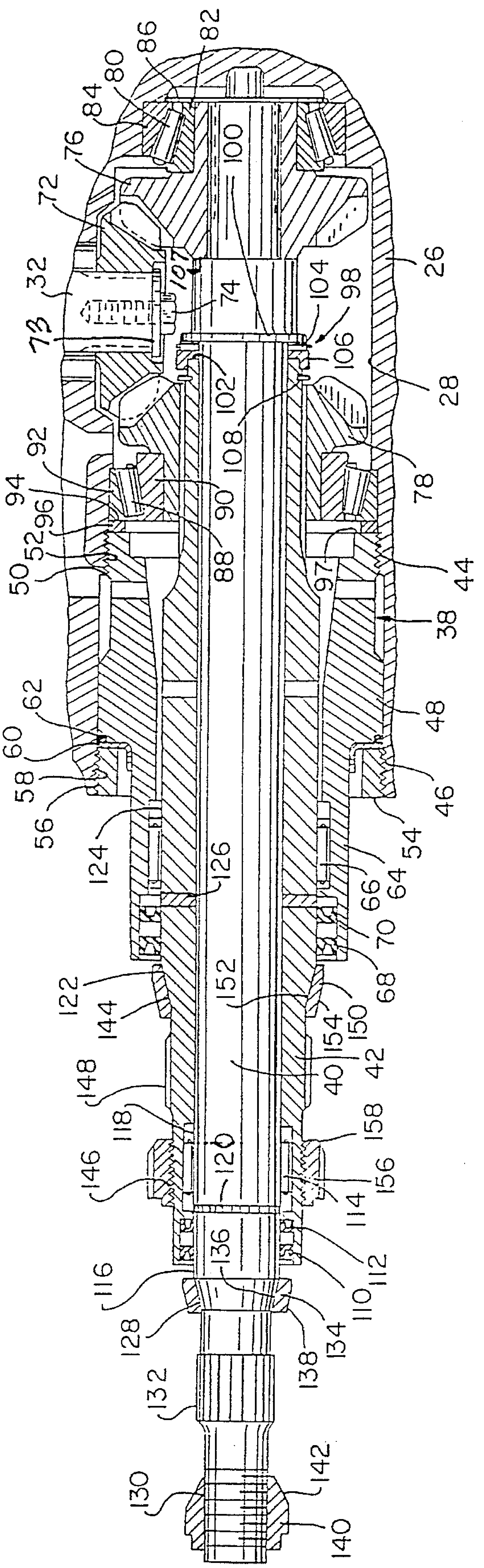

82
86
80
84
76
72
32
73
107
74
100
104
98
106
26
28
102
108
92
94
96
52
50
90
88
97
78
44
38
48
62
60
58
56
46
54
124
126
64
66
70
68
122
144
152
150
154
42
40
148
118
120
158
156
146
114
112
110
136
116
128
134
138
132
142
130
140

FIG. 3

FIG. 5

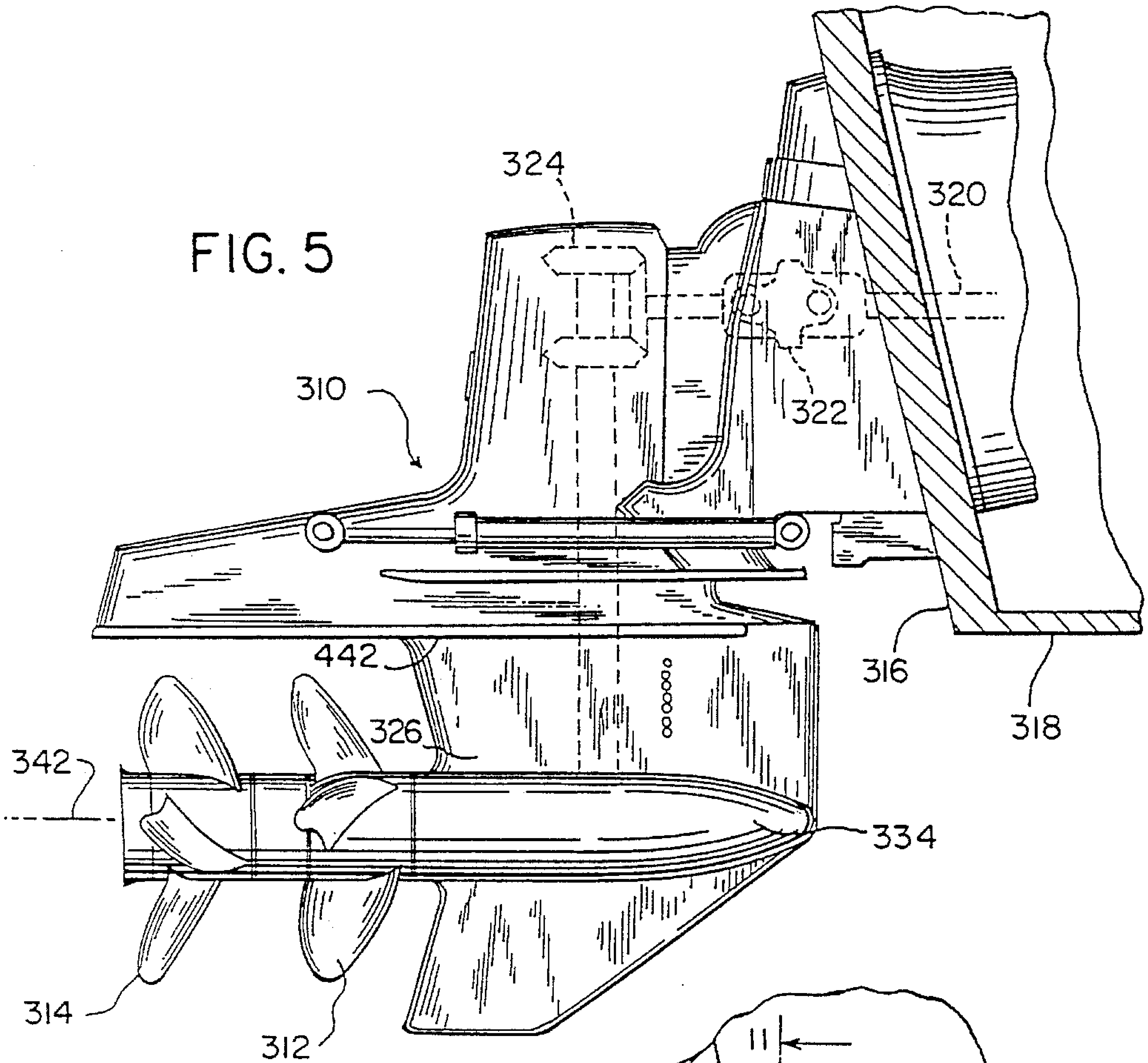
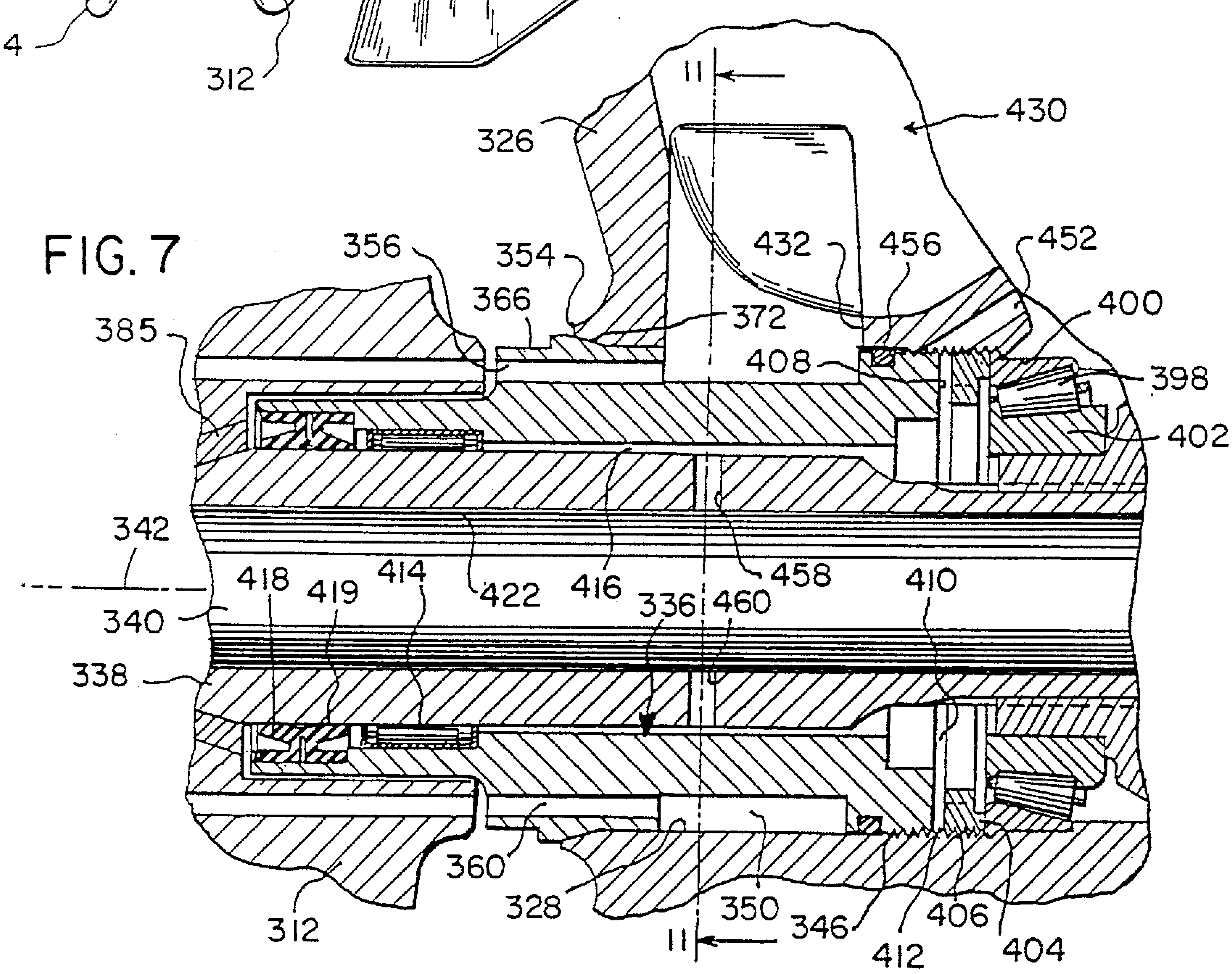

324
320
310
322
442
326
342
334
316
318
314
312

FIG. 7


11
430
326
356
354
432
456
452
366
372
400
385
408
398
402
342
418
419
414
422
416
336
460
458
410
340
338
360
328
350
346
406
404
312
412

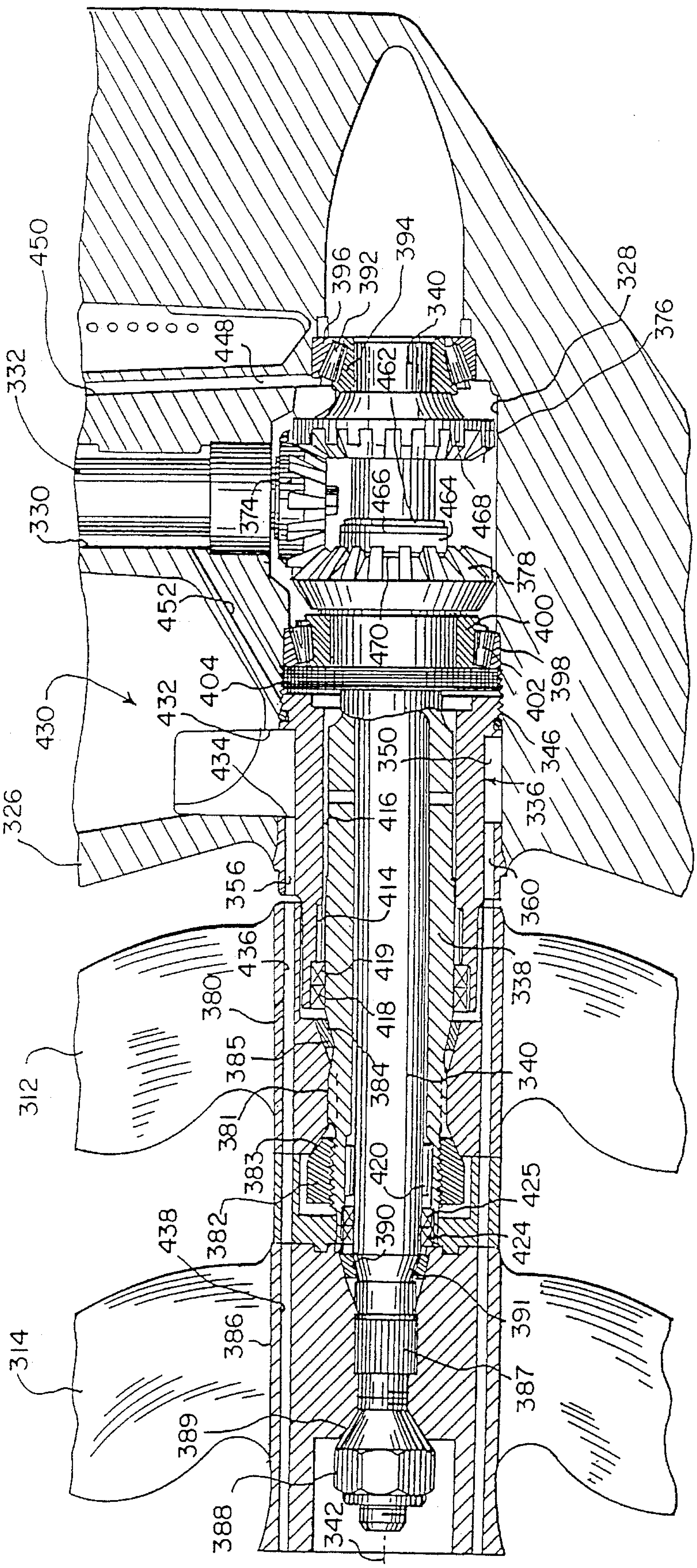

450
332
330
448
396
392
394
340
328
376
462
374
466
464
468
378
452
470
400
404
432
430
402
398
434
346
350
336
416
326
356
414
360
436
419
338
380
418
385
384
340
312
381
383
420
425
382
390
424
438
391
386
387
314
389
388
342

FIG.6

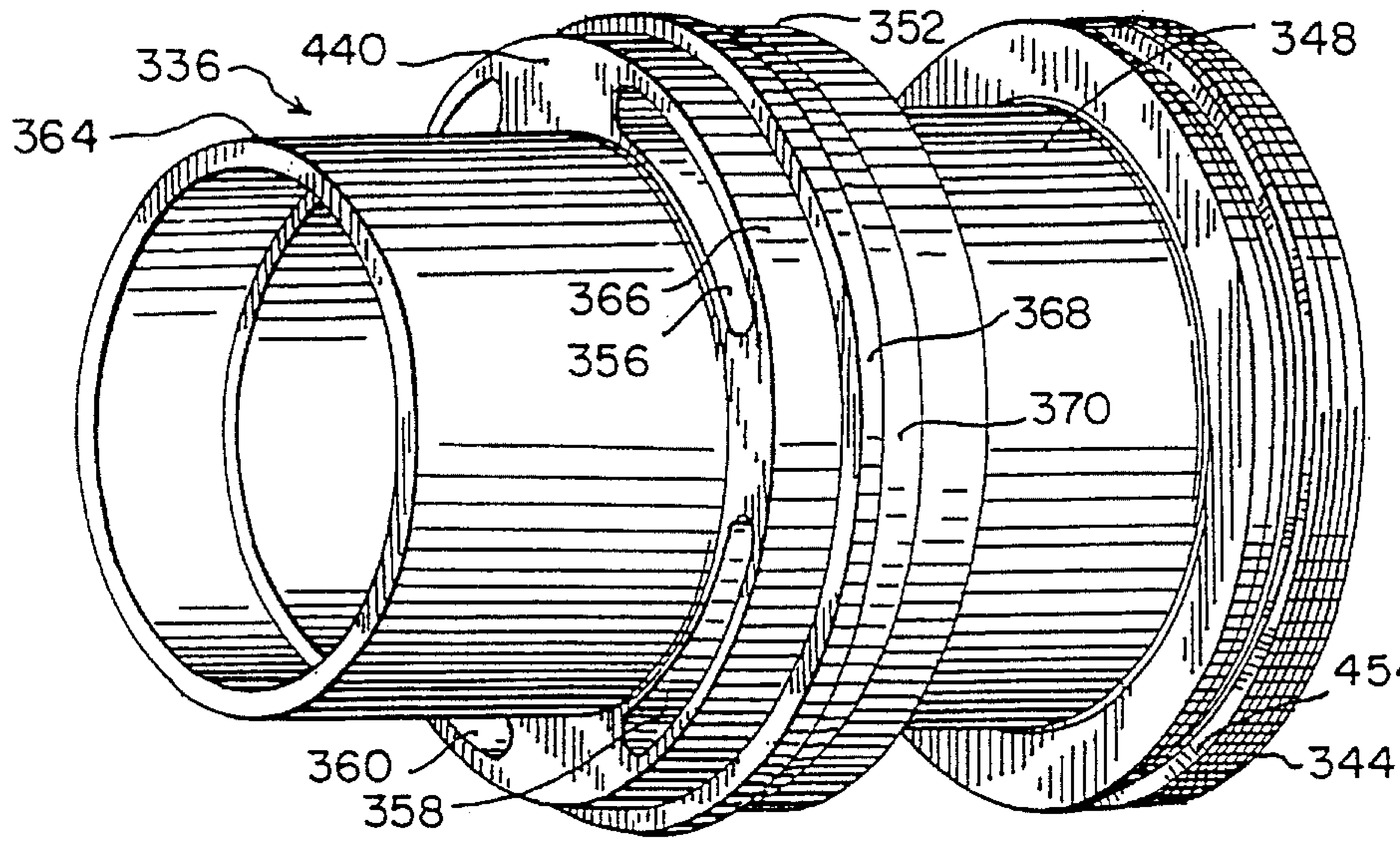


FIG. 8

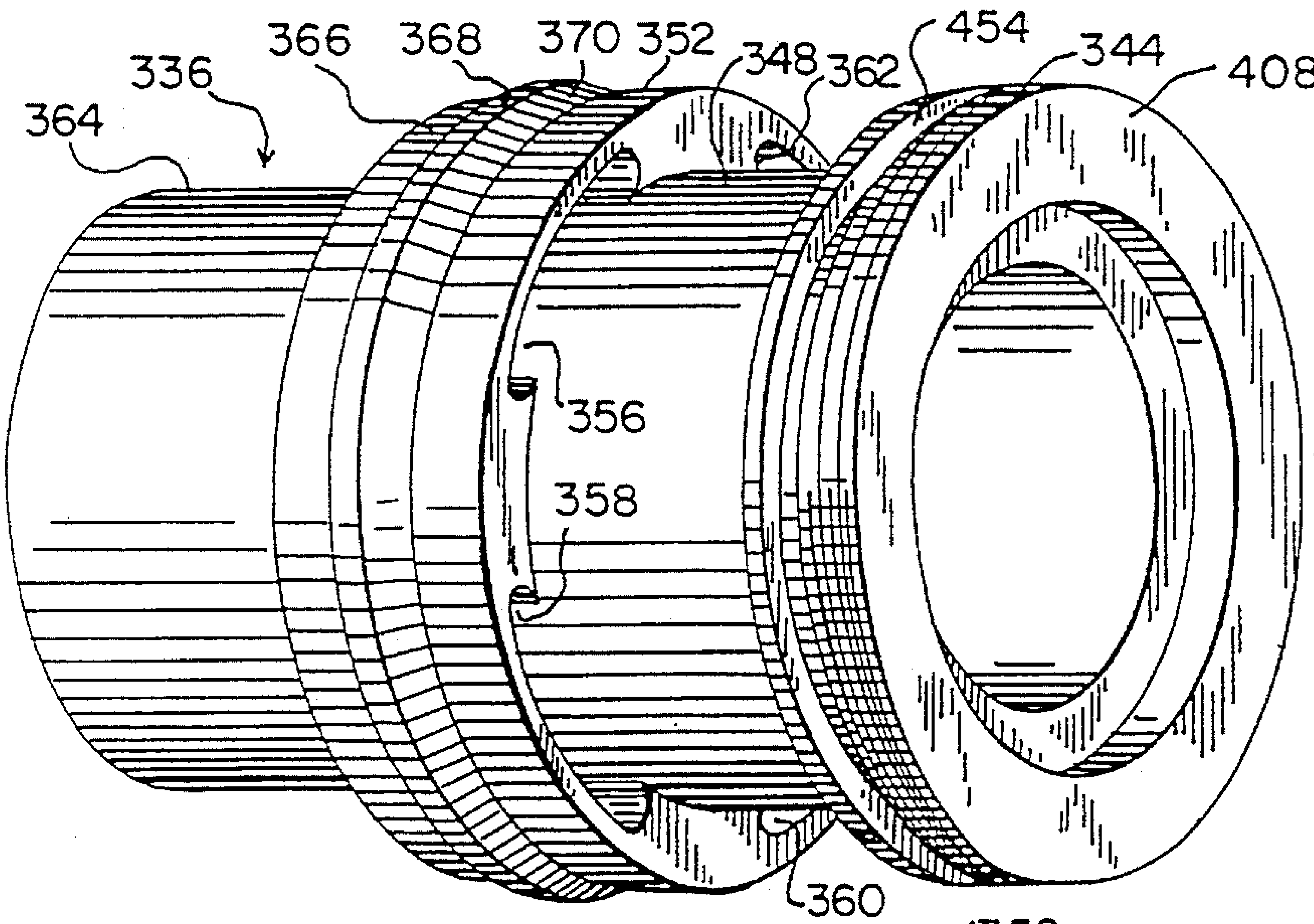


FIG. 9

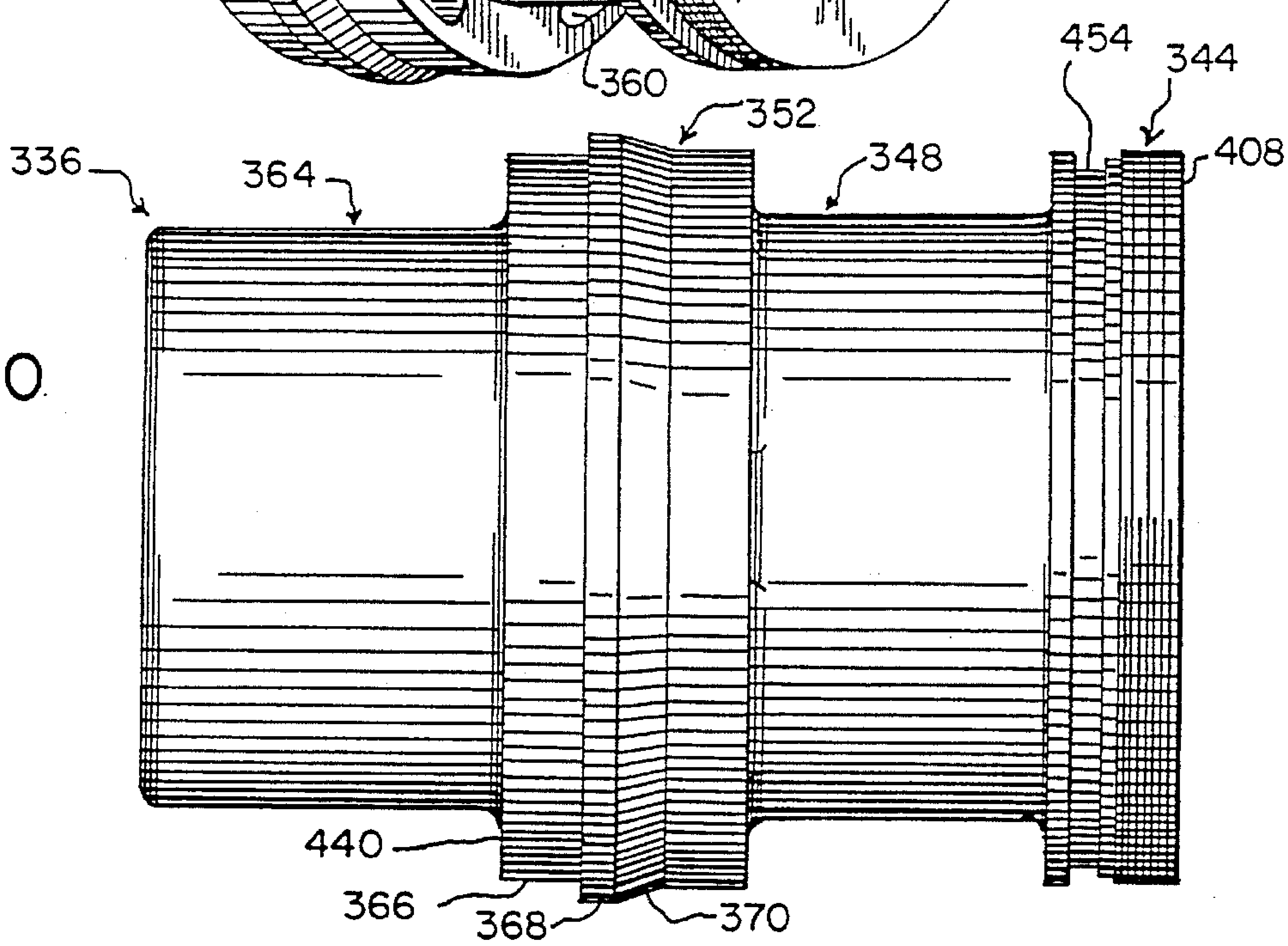


FIG. 10

FIG. 11

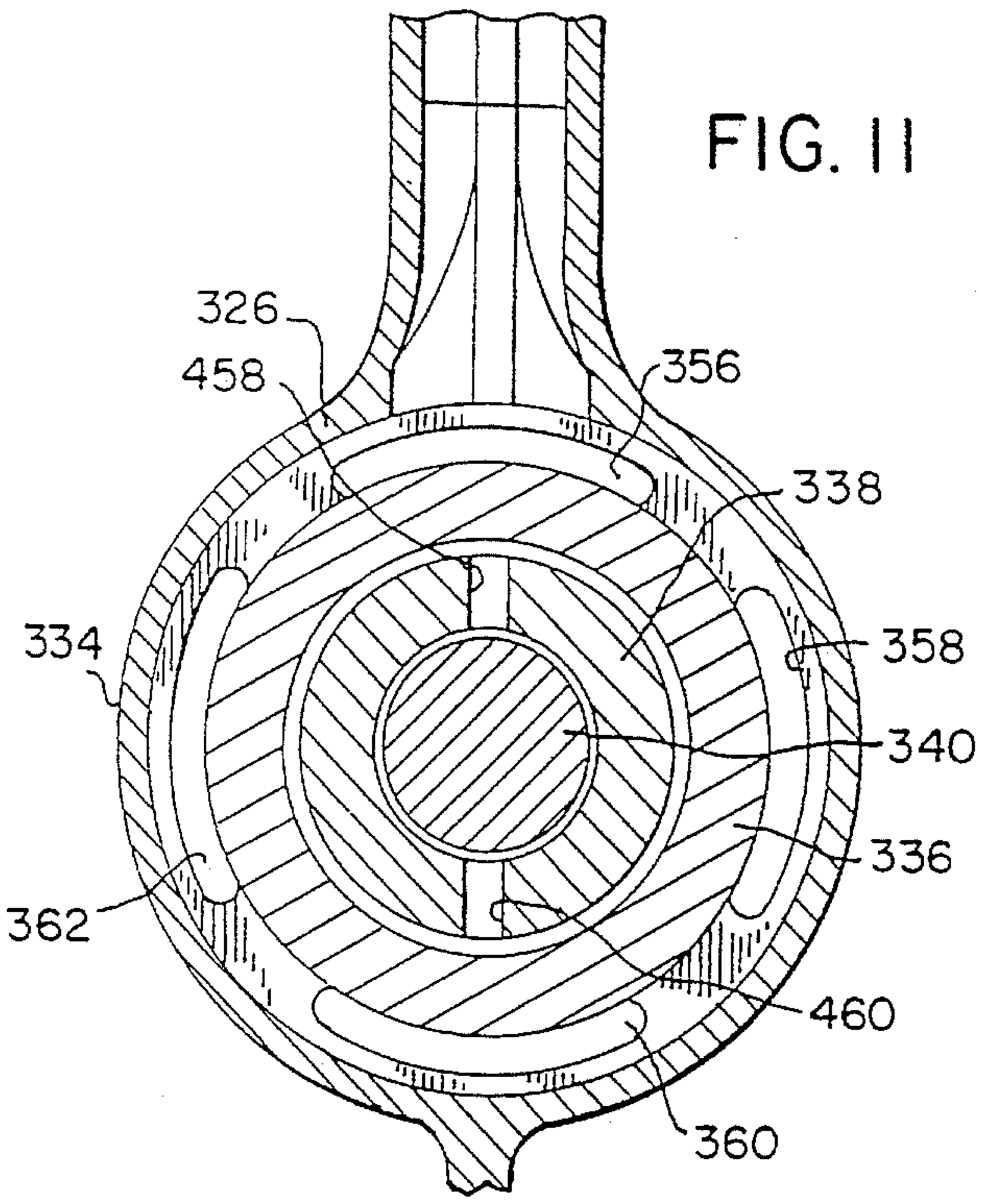


FIG. 12

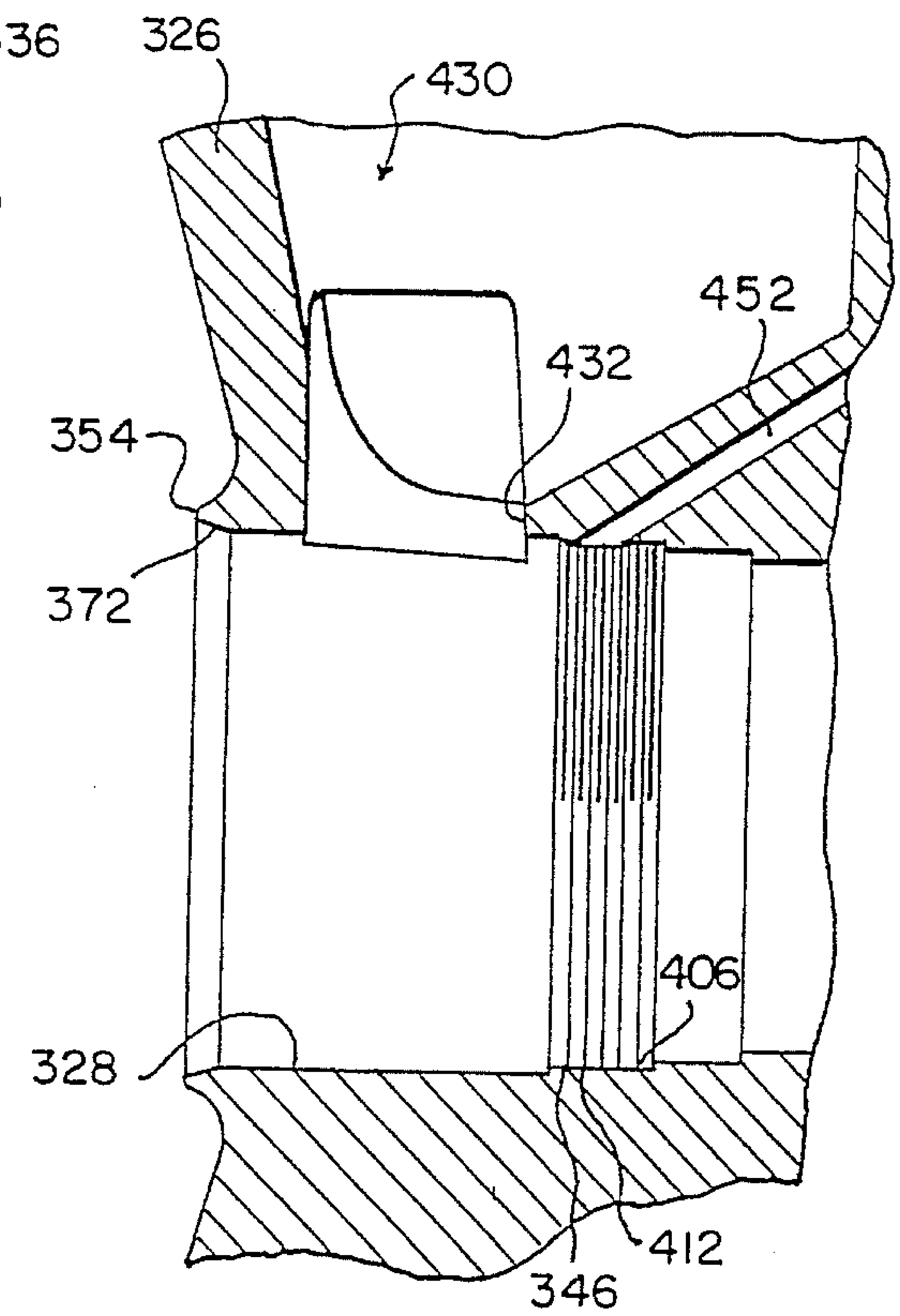
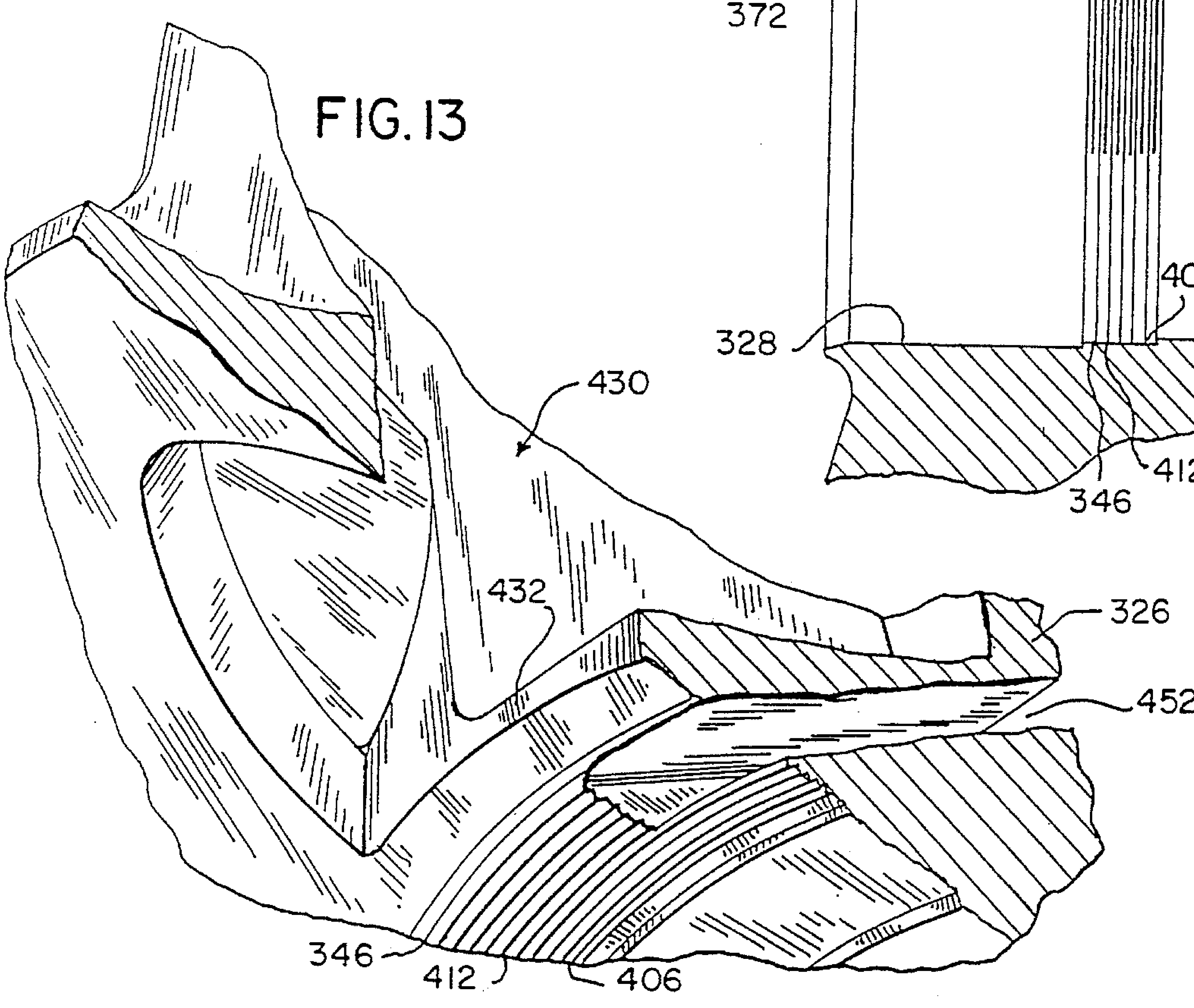


FIG. 13



MARINE DUAL PROPELLER LOWER BORE DRIVE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of application Ser. No. 08/069,163, filed May 28, 1993 U.S. Pat. No. 5,366,398, which is a continuation-in-part of application Ser. No. 07/889,530 U.S. Pat. No. 5,249,995, filed May 27, 1992.

BACKGROUND AND SUMMARY

The invention relates to a marine drive having dual counter-rotating coaxial propellers.

Dual propeller marine drives with concentric counter-rotating propeller shafts are known in the prior art. The present invention provides improvements, including locking retaining structure for holding the lower dual propeller shaft assembly in the lower horizontal bore in the housing, lubrication and exhaust communication, durability, and performance.

The invention further relates to commonly owned copending allowed application Ser. No. 07/889,495, filed May 27, 1992, and allowed application Ser. No. 07/892,399, filed May 28, 1992, incorporated herein by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view of a marine drive in accordance with the invention.

FIG. **2** is a partial sectional view of a portion of the structure of FIG. **1**.

FIG. **3** is an enlarged view of a portion of the structure of FIG. **2**.

FIG. **4** is an exploded perspective view of a portion of the structure of FIG. **1**.

FIG. **5** is a side elevation view of a marine drive in accordance with another embodiment of the invention.

FIG. **6** is an enlarged partial sectional view of a portion of the structure of FIG. **5**.

FIG. **7** is an enlarged partial sectional view of a portion of the structure of FIG. **6**.

FIG. **8** is a perspective view of the spool of FIG. **7**.

FIG. **9** is another perspective view of the spool of FIG. **8**.

FIG. **10** is a side elevation view of the spool of FIGS. **8** and **9**.

FIG. **11** is a sectional view taken along line **11**—**11** of FIG. **7**.

FIG. **12** is a section view of a portion of the structure of FIG. **7** with parts removed.

FIG. **13** is an enlarged perspective view of a portion of the structure of FIG. **12**.

DETAILED DESCRIPTION

FIG. **1** shows a marine drive **10** having two counter-rotating propellers **12** and **14**. The drive is mounted to the transom **16** of a boat **18** according to the usual marine stern drive mounting arrangement. An input shaft **20**, FIG. **2**, is driven by an engine (not shown) in the boat **18**. Input shaft **20** is coupled through a universal joint **22** to an upper gear and clutch mechanism **24** which is known in the art, as shown in U.S. Pat. Nos. 4,630,719, 4,679,682, and 4,869,121, incorporated herein by reference. Universal joint **22** allows trimming and steering of the drive.

Drive housing **26** has a horizontal bore **28** and an intersecting vertical bore **30** therein. Upper gear mechanism **24** drives a vertical driveshaft **32** positioned in vertical bore **30**. Horizontal bore **28** is in the portion of the drive housing called the torpedo **34**, FIG. **4**. A spool assembly **38**, FIG. **3**, is positioned in horizontal bore **28** of housing **26** and supports a first inner propeller shaft **40** and a second hollow outer propeller shaft **42**. Propeller shaft **42** is positioned concentrically over propeller shaft **40**. The propeller shafts rotate in opposite rotational directions. Propeller **12** is mounted to propeller shaft **40**. Propeller **14** is mounted to propeller shaft **42**. One of the propellers is a right hand rotating propeller, and the other propeller is a left hand rotating propeller.

Retaining structure is provided for holding the spool assembly **38** fixed for non-rotation within horizontal bore **28** in both rotational directions. The retaining structure is provided by a first right hand thread set **44**, FIG. **3**, and a second left hand thread set **46**. The thread sets are spaced along the rotational axis of the propeller shafts. Right hand thread set **44** prevents right hand rotational loosening of the spool assembly. Left hand thread set **46** prevents left hand rotational loosening of the spool assembly. The spool assembly includes a cylindrical bearing support housing **48**, FIGS. **3** and **4**, having a mounting thread **50** thereon for engagement with a mounting thread **52** in bore **28** of housing **26**. The spool assembly also includes a cylindrical ring locking member **54** having a left hand thread **56** for engagement with a mating thread **58** in bore **28** of housing **26**, for clamping against bearing support housing **48** to fix the rotational and axial position of both bearing support housing **48** and locking member **54** in horizontal bore **28**, whereby rotation of the spool assembly is prevented in each rotational direction. A locking tab washer **60** is provided between locking member **54** and bearing support housing **48**, and O-ring **62** provides a seal between bearing support housing **48** and drive housing **26** preventing entry of water forwardly into bore **28**. Flats **61** on washer **60** engage flats **49** on housing **48** to lock the washer **60** against rotation relative to housing **48**. Tabs **63** on washer **60** are bent outwardly into slotted recesses **55** on locking member **54** to prevent rotation of member **54** relative to washer **60**, which in turn prevents rotation of member **54** relative to housing **48**. Housing **48** is then locked into bore **28** by the noted reverse threads **50** and **56**. Spool retaining structure using a set screw is known in the prior art, for example U.S. Pat. No. 4,897,058.

The spool assembly includes an aft bearing support portion **64**, FIG. **3**, extending rearwardly outwardly from housing **26**. Needle bearing **66** is positioned between propeller shaft **42** and bearing support housing **48** in extended bearing support portion **64** such that the propeller shafts are supported over a length to prevent bending of the propeller shafts during operation. Bearings in rearwardly extended spool portions are known in the prior art, for example U.S. Pat. No. 4,897,058. One or more seals **68**, **70** are positioned between propeller shaft **42** and extended bearing support portion **64** of the spool assembly and aft of bearing **66** to prevent entry of water forwardly into the space between propeller shaft **42** and the spool assembly.

A pinion driving gear **72**, FIG. **3**, is mounted on the lower end of vertical driveshaft **32** in splined relation and is held thereon by washer **73** and capscrew **74**. A fore driven gear **76** is fixed on inner propeller shaft **40** in splined relation and is engaged by pinion gear **72** for drivingly rotating inner propeller shaft **40**. An aft driven gear **78** is fixed on outer propeller shaft **42** in splined relation and is engaged by pinion gear **72** for drivingly rotating outer propeller shaft **42** in the opposite rotational direction as inner propeller shaft

40. A tapered roller thrust bearing **80** supports driven gear **76** for rotation in bore **28** of housing **26**. Bearing **80** has an inner race **82** engaging gear **76**, and an outer race **84** engaging housing **26**. A shim **86** may be provided if desired for adjusting axial positioning. A second tapered roller thrust bearing **88** supports the aft driven gear for rotation in bore **28** of housing **26**. Bearing **88** has an inner race **90** engaging gear **78**, and an outer race **92** engaging housing **26**. Outer race **92** has a rearward end portion **94** facing the spool assembly and held thereby against axial movement, to prevent rearward movement of gear **78**. Spacer washer **96** is provided between rearward end **94** of outer race **92** and forward end **97** of bearing support housing **48** of spool assembly **38**.

A thrust bearing assembly **98**, FIG. **3**, engages between the propeller shafts such that thrust from outer propeller shaft **42** is transferred to inner propeller shaft **40** during rotation of the propeller shafts in opposite directions. Inner propeller shaft **40** extends through fore driven gear **76** and aft driven gear **78**. Outer propeller shaft **42** extends through aft driven gear **78**. Inner propeller shaft **40** has an annular shoulder **100** against which the thrust from outer propeller shaft **42** is transferred. Thrust bearing assembly **98** is mounted between shoulder **100** and the forward axial end **102** of outer propeller shaft **42**. Thrust bearing assembly **98** is located axially between fore driven gear **76** and aft driven gear **78**, such that thrust is transferred from outer propeller shaft **42** to inner propeller shaft **40** at an axial position on the propeller shafts located between gears **76** and **78**. Thrust bearing assembly **98** includes a thrust bearing **104** engaging shoulder **100** of inner propeller shaft **40**, and an annular cup-shaped thrust member **106** engaging thrust bearing **104** and the forward end **102** of outer propeller shaft **42** to transfer thrust from outer propeller shaft **42** to inner propeller shaft **40**. Inner propeller shaft **40** has a forwardly facing annular shoulder **107** engaging the rearwardly facing axial end of fore gear **76**, such that forward thrust is transferred from inner propeller shaft **40** to fore driven gear **76** and then to tapered roller thrust bearing **80**. Snap ring **108** stops rearward movement of the shafts in the reverse direction. The propeller shafts are allowed to slide fore and aft within their respective gears **76** and **78** along their respective splines, providing a floating shaft arrangement. Thrust bearing assembly **98** is a double speed bearing and accommodates the opposite rotational directions of the propeller shafts.

One or more annular seals **110**, **112**, FIG. **3**, are positioned between inner propeller shaft **40** and outer propeller shaft **42** at the propeller mounting end of propeller shaft **40** such that water is prevented from entering forwardly into the space between the propeller shafts. A needle bearing **114** is positioned between inner propeller shaft **40** and outer propeller shaft **42** and forward of seals **110**, **112**. Propeller shaft **40** has a stainless steel outer surface **116** rearward of seals **110**, **112**, and a carbon steel outer surface **118** forward of the seals at bearing **114**. In one embodiment, inner propeller shaft **40** is a two piece member formed by a forward carbon steel piece and a rearward stainless steel piece welded to each other at a weld joint **120** between bearing **114** and the seals **110**, **112**. In another embodiment, inner propeller shaft **40** is a stainless steel member having a carbon steel sleeve therearound at bearing **114**. Outer propeller shaft **42** has a stainless steel outer surface **122** rearward of seals **68**, **70**, and a carbon steel outer surface **124** forward of the seals at bearing **66**. In one embodiment, outer propeller shaft **42** is a two piece member formed by a forward carbon steel piece and a rearward stainless steel piece welded to each other at a weld joint **126**. In another embodiment, outer propeller shaft **42** is a stainless steel member having a carbon steel sleeve therearound at bearing **66**.

Self-centering mounting structure is provided for the propellers on each propeller shaft. Inner propeller shaft **40** has a tapered shoulder outer surface **128**, FIG. **3**, a threaded outer surface **130** axially spaced rearwardly of tapered outer surface **128**, and a driving spline **132** therebetween and drivingly engaging propeller **12** in splined relation. An annular ring **134** of a material, e.g. bronze, non-fretting relative to stainless steel, has an inner tapered surface **136** engaging tapered outer surface **128** of inner propeller shaft **40**. Ring **134** has a tapered outer surface **138**. An internally threaded nut **140** of a material, e.g. bronze, non-fretting relative to stainless steel, threadingly engages threaded outer surface **130** of inner propeller shaft **40**. Nut **140** has a tapered outer surface **142**. Propeller **12** is mounted on inner propeller shaft **40** between ring **134** and nut **140** and is engaged forwardly at tapered outer surface **138** of ring **134**, and is engaged rearwardly at tapered outer surface **142** of nut **140**. Tapers **138** and **142** provide a tight self-centering fit and mounting of the propeller to the propeller shaft. Splines **132** do not provide a tight fit, but merely rotational drive.

Outer propeller shaft **42** has a tapered shoulder outer surface **144**, FIG. **3**, a threaded outer surface **146** axially spaced rearwardly of tapered outer surface **144**, and a driving spline **148** therebetween for drivingly engaging propeller **14** in splined relation. A ring **150** of a material, e.g. bronze, non-fretting relative to stainless steel, has a tapered inner surface **152** engaging tapered outer surface **144** of outer propeller shaft **42**. Ring **150** has a tapered outer surface **154**. An internally threaded nut **156** of a material, e.g. bronze, non-fretting relative to stainless steel, threadingly engages threaded outer surface **146** of outer propeller shaft **42**. Nut **156** has a tapered outer surface **158**. Propeller **14** is mounted on outer propeller shaft **42** between ring **150** and nut **156** and is engaged forwardly at tapered outer surface **154** of ring **150**, and is engaged rearwardly at tapered outer surface **158** of nut **156**. Tapers **154** and **158** provide a tight self-centering fit. Splines **148** do not provide a tight fit, but only rotational drive.

Vertical driveshaft **32**, FIG. **2**, is a two-piece member formed by an upper driveshaft segment **32*a*** and a lower driveshaft segment **32*b*** coupled by a sleeve **33** in splined relation for example as shown in incorporated U.S. Pat. No. 4,869,121. Upper driveshaft segment **32*a***, FIG. **2**, is supported at its top end by a needle bearing **160** as in the above incorporated patents. Lower driveshaft segment **32*b*** is supported at its lower end by a needle bearing **162**. Driveshaft **32** is centrally supported at the upper end of lower segment **32*b*** in bore **30** by tapered roller thrust bearing **164** retained by threaded ring **166**. Upper segment **32*a*** is also supported by needle bearing **168** in upper spool **170** mounted at threads **172** in bore **30**, and also having a needle bearing **174** supporting gear **176** of upper gear assembly **24**.

Cooling water for the engine is supplied from water intake **178** in skeg **180**. The water flows through skeg passage **182**, torpedo nose passage **184** and then through housing passage **186** and then to the engine in the usual manner. After cooling the engine, the water and the engine exhaust are exhausted in the usual manner through an exhaust elbow and through the drive housing and are discharged at exhaust outlet **188** above torpedo **34** and into the path of the propeller blades in the upper portion of their rotation, as in U.S. Pat. No. 4,871,334. In an alternate embodiment, the exhaust is discharged through the transom, and not through the drive. Oil circulates from the lower gears upwardly through passages

190 and 192 to the upper gears and then downwardly through passage 194 to the lower gears at passages 196 and 197. Passage 196 supplies oil through passage 198 in the spool assembly to bearings 88 and 66, and through passage 199 in outer propeller shaft 42 to bearing 114. Passage 197 supplies oil to the forward end of bearing 88.

FIG. 5 shows a marine drive 310 having two counter-rotating propellers 312 and 314. The drive is mounted to the transom 316 of a boat 318 according to the usual marine stern drive mounting arrangement. An input shaft 320 is driven by an engine (not shown) in the boat. Input shaft 320 is coupled through a universal joint 322 to an upper gear and clutch mechanism 324 which is known in the art, as shown in U.S. Pat. No. 4,630,719, 4,679,682, and 4,869,121, incorporated herein by reference. Universal joint 322 allows trimming and steering of the drive. Drive housing 326 has a lower horizontal bore 328, FIG. 6, and an intersecting vertical bore 330 therein. Upper gear mechanism 324 drives a vertical drive shaft 332, as shown in incorporated U.S. Pat. No. 4,869,121, positioned in vertical bore 330. Horizontal bore 328 is in the portion of the drive housing called the torpedo 334, FIG. 5.

A spool 336, FIGS. 4–10, is positioned in horizontal bore 328 and supports a dual propeller shaft assembly, including a hollow outer propeller shaft 338 positioned in spool 336, and an inner propeller shaft 340 positioned in outer propeller shaft 338. The inner and outer propeller shafts are concentric and rotate in opposite rotational directions along a common axis 342. Spool 336 is a cylindrical member having a forward first outer diameter portion 344, FIG. 10, threadingly engaging housing 326 within horizontal bore 328 at thread set 346, FIG. 7. The spool includes a second reduced outer diameter portion 348, FIG. 10, within horizontal bore 328, FIGS. 6 and 7, and aft of first outer diameter portion 344, FIG. 10, and defining an annular recess 350, FIGS. 6 and 7. Spool 336 includes a third outer diameter portion 352, FIG. 10, aft of second outer diameter portion 348 and engaging drive housing 326 at the aft end 354, FIG. 7, of horizontal bore 328. Third outer diameter portion 352 has a plurality of slots 356, 358, 360, 362, FIGS. 7–9 and 11, extending rearwardly therethrough. Spool 336 has a fourth reduced outer diameter portion 364 aft of third outer diameter portion 352 and external of horizontal bore 328.

Third outer diameter portion 352 of spool 336 extends rearwardly at 366, FIGS. 10 and 7, externally of horizontal bore 328. Third outer diameter portion 352 includes a raised annular shoulder 368 of outer diameter greater than the inner diameter of horizontal bore 328 and engaging housing 326 at aft end 354 of horizontal bore 328. Raised annular shoulder 368 has a forward portion 370, FIG. 10, tapered forwardly to reduced outer diameters. Horizontal bore 328 at aft end 354 is tapered at 372, FIG. 7, rearwardly to increasing inner diameters and snugly engages forward tapered portion 370 of raised annular shoulder 368 in flush relation.

A pinion driving gear 374, FIG. 6, is mounted on the lower end of vertical drive shaft 332, as is standard. A first driven gear 376 is fixed on inner propeller shaft 340 in splined relation and is engaged by pinion gear 374 and drivingly rotates inner propeller shaft 340 in a first rotational direction. A second driven gear 378 is fixed on outer propeller shaft 338 in splined relation and is engaged by pinion gear 374 and drivingly rotates outer propeller shaft 338 in a second opposite rotational direction, as is standard. Self-centering mounting structure is provided for the propellers on each propeller shaft, as above. Forward propeller 312 has a hub 380 mounted to outer propeller shaft 338 at splines 381 and is held thereon by threaded nut 382 and is axially engaged between and against tapered engagement surfaces 383 and 384 respectively on tapered nut 382 and tapered thrust hub ring 385 on outer propeller shaft 338. Tapers 383 and 384 provide a tight self-centering fit and mounting of the propeller to the propeller shaft. Splines 381 do not provide a tight fit, but merely rotational drive. Aft propeller 314 has a hub 386 mounted to inner propeller shaft 340 at splines 387 and is held thereon by threaded nut 388 and is axially engaged between and against tapered engagement surfaces 389 and 390 respectively on tapered nut 388 and tapered thrust hub ring 391 on inner propeller shaft 340. Tapers 389 and 390 provide a tight self-centering fit and mounting of the propeller to the propeller shaft. Splines 387 do not provide a tight fit, but merely rotational drive. In the preferred embodiment, spool 336 is mounted by left hand threads 346 in the housing, and forward propeller 312 is a left hand rotation propeller, and aft propeller 314 is a right hand rotation propeller.

A forward tapered roller thrust bearing 392 supports forward driven gear 376 in the housing, and includes an inner race 394 engaging gear 376, and an outer race 396 engaging housing 326 in bore 328. An aft tapered roller thrust bearing 398 supports aft driven gear 378 in the housing, and includes an inner race 400 engaging gear 378 and an outer race 402 engaging housing 326 in bore 328. A threaded locking ring 404, FIGS. 6 and 7, is thread mounted within horizontal bore 328 at thread set 406 and engages outer race 402 to prevent rearward movement of driven gear 378 and to adjust loading of same.

Thread set 346, mounting spool 336, FIG. 7, and thread set 406 mounting locking ring 404 are axially spaced such that the forward end 408 of spool 336 is spaced rearwardly of locking ring 404 by an axial gap 410 therebetween. Thread sets 346 and 406 may be separate threads, however it is preferred that they be provided by a continuous thread cut into horizontal bore 328 and having a forward portion at 406 for mounting locking ring 404, an aft portion at 346 for mounting spool 336, and a middle portion at 412 at axial gap 410. This enables a single machining threading operation to provide both thread sets 346 and 406.

A first aft bearing 414, FIGS. 6 and 7, within a first annulus 416 between outer propeller shaft 338 and spool 336 supports the outer propeller shaft for rotation within the spool. Annular seal 418 aft of bearing 414 prevents entry of water forwardly into annulus 416. Annular seal 419 prevents exit of lubricant rearwardly from annulus 416. A second aft bearing 420 in a second annulus 422 between inner propeller shaft 340 and outer propeller shaft 338 supports the inner propeller shaft for rotation within the outer propeller shaft. Annular seal 424 aft of bearing 420 prevents entry of water forwardly into annulus 422. Annular seal 425 prevents exit of lubricant rearwardly from annulus 422.

An engine exhaust passage 430, FIG. 6, is provided by a passage 432 in housing 326 communicating with horizontal bore 328 at spool 336. The exhaust passage continues at 434 through annular recess 350 provided by second outer diameter portion 348 of spool 336, and then rearwardly through slot passages 356, 358, 360, 362. The exhaust then passes rearwardly through hub exhaust passages 436 and 438 of the forward and aft propeller hubs 380 and 386. The exhaust passage at 434 includes a forward portion at recess 350 receiving exhaust from passage 430, and an aft portion at slots 356, 358, 360, 362 extending rearwardly from recess 350 toward and axially aligned with through-hub exhaust passages 436, 438. Third outer diameter portion 352 of spool 336 has an aft end 440, FIG. 10, defining an annulus facing axially rearwardly toward hub 380 of forward propeller 312.

Fourth outer diameter portion **364** of spool **336** extends rearwardly within hub **380**, and exhaust through hub **380** is concentric around fourth outer diameter portion **364**. In the preferred embodiment, the plurality of arcuate slots **356**, **358**, **360**, **362** have a cumulative area of at least about two square inches for a **502** cubic inch displacement engine. Further in the preferred embodiment, additional exhaust outlets from passage **430** are provided in the area of anti-cavitation plate **442**, as is known, for additional exhaust relief if desired.

Positive pressure gradients at area **448**, FIG. **6**, provides an oil pumping function, for which further reference may be had to incorporated allowed application Ser. No. 07/892, 399, filed May 28, 1992, to circulate oil upwardly through oil passage **450** to upper gear mechanism **324**, FIG. **5**, which oil is returned through vertical bore **330**. Housing **326** includes an oil passage **452**, FIGS. **6**, **7**, **12**, **13**, extending from vertical bore **330** and communicating with horizontal bore **328** forwardly of exhaust passage **432**. Oil passage **452** lubricates the dual propeller shaft assembly.

Spool **336** includes an annular groove **454** at first outer diameter portion **344**, and has an annular O-ring seal **456**, FIG. **7**, in groove **454** and engaging housing **326** within horizontal bore **328** at a location axially between passages **432** and **452**, and sealing passage **432** from passage **452**, to thus prevent exhaust from entering the oil flow passages, and vice versa. Seal **456** is also axially between passage **432** and thread set **346**. At least a portion of thread set **346** is axially between seal **456** and passage **452**. Passage **452** communicates with horizontal bore **328** at axial gap **410**. Oil passage **452** supplies oil to annulus **416** through gap **410**, to lubricate bearing **414**. Outer propeller shaft **338** has radial passages **458**, **460** therethrough, providing oil passages supplying oil from annulus **416** to annulus **422** to lubricate bearing **420**. Oil passages **458**, **460** are spaced radially inwardly of exhaust passages **432**, **350**, **356**, **358**, **360**, **362**. Seal **456** is forward of oil passages **458**, **460**.

A thrust bearing **462**, FIG. **6**, engages between the propeller shafts such that thrust from outer propeller shaft **338** is transferred to inner propeller shaft **340** during rotation of the propeller shafts in opposite directions, as above. Inner propeller shaft **340** extends through fore driven gear **376** and aft driven gear **378**. Outer propeller shaft **338** extends through aft driven gear **378**. Inner propeller shaft **340** has an annular shoulder **464** against which the thrust from outer propeller shaft **338** is transferred. Thrust bearing **462** is mounted between shoulder **464** and the forward axial end **466** of outer propeller shaft **338**. Thrust bearing **462** is located axially between fore driven gear **376** and aft driven gear **378**, such that thrust is transferred from outer propeller shaft **338** to inner propeller shaft **340** at an axial position on the propeller shafts located between gears **376** and **378**. Inner propeller shaft **340** has a forwardly facing annular shoulder **468** engaging fore driven gear **376**, such that the thrust is then transferred from inner propeller shaft **340** to fore driven gear **376** and then to tapered roller thrust bearing **392**. The propeller shafts are allowed to slide fore and aft within their respective gears **376** and **378** along their respective splines, providing a floating shaft arrangement. Thrust bearing **462** is a double speed bearing and accommodates the opposite rotational directions of the propeller shafts. Snap ring **470** prevents rearward movement of shaft **340**.

It is recognized that various equivalents, alternatives and modifications are possible within the scope of the appended claims. Various of the principles of each embodiment are applicable to both surfacing and submerged drives, i.e. to both surface-operating propellers and to submerged-operation propellers.

We claim:

1. A marine drive comprising:

a housing having a horizontal bore and an intercepting vertical bore therein;

a vertical driveshaft positioned in said vertical bore;

a spool positioned in said horizontal bore and having a forward end terminating aft of said vertical bore;

a first inner propeller shaft;

a second hollow outer propeller shaft positioned over said first propeller shaft to form a dual propeller shaft assembly,

said dual propeller shaft assembly positioned in said horizontal bore and supported by said spool,

said first propeller shaft counter-rotating with respect to said second propeller shaft;

a first passage in said housing communicating with said horizontal bore rearwardly of said forward end of said spool and rearwardly of said vertical bore;

a second passage in said housing communicating with said horizontal bore forwardly of said forward end of said spool and rearwardly of said vertical bore and circulating lubricant to said horizontal bore, said second passage being exclusively a lubricant passage.

2. The invention according to claim **1** wherein said spool comprises a cylindrical member comprising:

a first outer diameter portion engaging said housing within said horizontal bore;

a second reduced outer diameter portion within said horizontal bore and aft of said first outer diameter portion and defining an annular recess, wherein said first passage communicates with said horizontally bore and said annular recess;

a third outer diameter portion aft of said second outer diameter portion and engaging said housing.

3. The invention according to claim **1** wherein each of said first and second passages is an oil passage.

4. The invention according to claim **1** wherein said first passage is an exhaust passage, and said second passage is an oil passage.

5. A marine drive comprising:

a housing having a horizontal bore and an intercepting vertical bore therein;

a vertical driveshaft positioned in said vertical bore;

a spool positioned in said horizontal bore and having a forward end terminating aft of said vertical bore;

a first inner propeller shaft;

a second hollow outer propeller shaft positioned over said first propeller shaft to form a dual propeller shaft assembly,

said dual propeller shaft assembly positioned in said horizontal bore and supported by said spool,

said first propeller shaft counter-rotating with respect to said second propeller shaft;

a first passage in said housing communicating with said horizontal bore rearwardly of said forward end of said spool and rearwardly of said vertical bore;

a second passage in said housing communicating with said horizontal bore forwardly of said forward end of said spool and rearwardly of said vertical bore,

wherein said spool is thread mounted within said housing by a set of threads within said horizontal bore, said threads being axially between said first and second passages.

6. A marine drive comprising:

a housing having a horizontal bore and an intersecting vertical bore therein;

a first inner propeller shaft;

a second hollow outer propeller shaft positioned over said first propeller shaft to form a dual propeller shaft assembly,

said dual propeller shaft assembly positioned in said horizontal bore,

said first propeller shaft counter-rotating with respect to said second propeller shaft;

a vertical driveshaft positioned in said vertical bore;

a pinion driving gear mounted on the lower end of said vertical driveshaft;

a fore driven gear on said first inner propeller shaft and engaged by said pinion gear to drivingly rotate said first propeller shaft in a first rotational direction;

an aft driven gear on said second propeller shaft and engaged by said pinion gear to drivingly rotate said second propeller shaft in a second rotational direction;

a tapered roller bearing supporting said aft driven gear for rotation in said housing, said tapered roller bearing having

an inner race engaging said aft driven gear, and

an outer race engaging said housing;

a threaded locking member engaging said housing in thread mounted relation within said horizontal bore and holding said tapered roller bearing in place and preventing rearward movement of said tapered roller bearing and said aft driven gear;

a passage in said housing communicating with said horizontal bore:

a spool in said housing supporting said dual propeller shaft assembly, said spool having a first outer diameter portion engaging said housing within said horizontal bore, and a second reduced outer diameter portion within said horizontal bore and aft of said first outer diameter portion and defining an annular recess, wherein said passage communicates with said horizontal bore at said annular recess, wherein said locking member is between said spool and said aft driven gear.

7. The invention according to claim 6 wherein said locking member and said spool are spaced by a tolerance-accommodating axial gap along said second propeller shaft.

* * * * *